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SPATIAL INFORMATION FOR FOREST PLANNING: AN EVALUATION OF ECOSYM/SPANMAP

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SPATIAL INFORMATION FOR FOREST PLANNING: AN EVALUATION OF ECOSYM/SPANMAP

FINAL REPORT
FOR
COOPERATIVE AGREEMENT
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between Utah State University and
the Rocky Mountain Forest and
Range Experiment Station - USDA forest service
and between
the University of California, Berkeley
and
Utah State University

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PROJECT HISTORY

This project was created as applications, technology transfer sequel to the developmental ECOSYM project conducted from 1976 to 1980 at Utah State University with support from the SEAM RD&A program of the USDA forest service and the WELUT program of the US Fish and Wildlife Service. ECOSYM [1] is a comprehensive management information system for land management that includes land classification, managerial oriented information analysis and graphic information processing technology. The system is designed to be practical and operable at the National Forest/Ranger District level. SPANMAP is the name of the computer analysis and graphics program used.

This project was directed to operationally demonstrate how current forest personnel could apply ECOSYM to resolve important, practical forest project analysis and planning problems. Additionally, the objective was to generally extend ECOSYM concepts and institutionalize the system for continuing future development and application.

The original strategy for achieving these objectives was to operationally implement ECOSYM in the Manti La Sal National forest and use this as the testing and demonstration site. The Resources Evaluation Program of the Rocky Mountain Station was to be the coordination and/or institutional location of the system.

Events conspired to disrupt this procedural strategy. Lack of resources prevented the Manti La Sal forest from meeting the data development schedule in the

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[1] ECOSYM
A full description of the ECOSYM project and concept is found in Davis, L.S. 1980 strategy for building a location specific multi-purpose information system for wildland management. J. Forestry 78:402-408 and Henderson, J.A., L.S. Davis, and E.M. Ryberg, 1978. ECOSYM: a classification and information system for wildland resource management. Department of Forest Resources, Utah State University, Logan.

contract and the forest could not be effectively used as a demonstration site. The Resource Evaluation project was terminated and the principal investigator moved fro Utah State University to the University of California at Berkeley.

In the search for alternatives, partial data sets from the Payette and Willamette National forests were found and a hypothetical but representative 20,000 acre watershed with an ECOSYM type data base called Tanner Creek was created. The focus of the project then shifted from conducting a large scale operational demonstration to that of demonstrating by example how ECOSYM could support NFMA Forest Planning, particularly the spatial considerations, and link to provide input support for analysis by FORPLAN I and FORPLAN II (D.E. Forplan). The Land Management Planning support groups at Fort Collins, Co. may be a logical, long-term institutional support group for the system. In addition ECOSYM/SPANMAP will be supported as a research system by the Department of Forestry and Resource Management, University of California.

While the procedures and locale of this study have changed considerably from the original design, the guiding original objectives have been largely satisfied. The successful application of ECOSYM to project and forest planning problems has been demonstrated to several clientele groups, technology has been advanced, some new concepts developed, and hopefully transferred to an institutional home. ECOSYM ideas have been kept alive and are finding wider acceptance and use.

SPATIAL ASPECTS OF FOREST PLANNING: THE PROBLEM

Forest planning is an activity which involves (1) accessing the capabilities of a forest land resource system, (2) evaluating possible resource use options in terms of the goals and constraints of the forest owner(s), and (3) providing as output a schedule of activities to implement on the ground. This schedule lists in a tir

sequence the treatments to be applied to each different type or strata of land defined for the planning analysis.

A schedule has place or 'where' content to the extent that the strata chosen for analysis have location identity as specific parcels of land. If land is identified by type of land only, then there is no location direction to the plan's activity schedule. If the land is stratified by type and large geographic units such as counties, ranger districts or watersheds, then approximate location direction is given. If each contiguous geographic parcel is identified as a separate strata in the analysis, then the plan's activity schedule is fully identified as to where all treatments are to take place. Figure 1 reviews these distinctions. Its clear that increasing location specificity of a schedule involves defining a greater number of planning model strata. As those familiar with planning using linear programming (such as with FORPLAN) are well aware, more strata means bigger models and much higher analytical cost, not to mention the cost of obtaining adequate locational data to drive the analysis on the input side.

Whether locationally explicit or not, for any plan to be implemented the scheduled activities have to be assigned to specific acres. If the plan doesn't give guidance for location then the forester and others implementing the plan make the choices. Its only when planned activities are finally assigned or implemented on the ground that we finally obtain a time and location picture of what the plan means when its "in place". This is the final reality check and if the implemented schedule is not deemed acceptable to the forest owner(s) then we can say it is <u>spatially infeasible</u>. That is we don't like the way it works out on the ground.

<u>Spatial Infeasibility</u>

Spatial infeasibility is largely a subjective human judgment based on a mixture

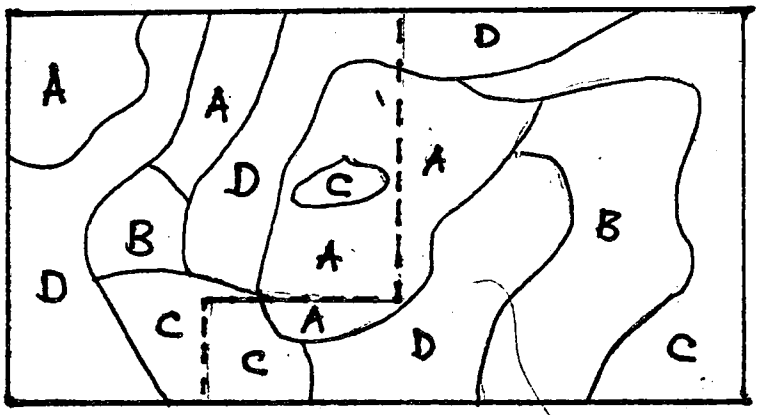

Figure 1a: land classification with zero location information.

Land strata = stand types
Number or strata = 4

A = operable timber stands
B = visually sensitive stands with restrictive logging
C = critical wildlife habitat
D = other land

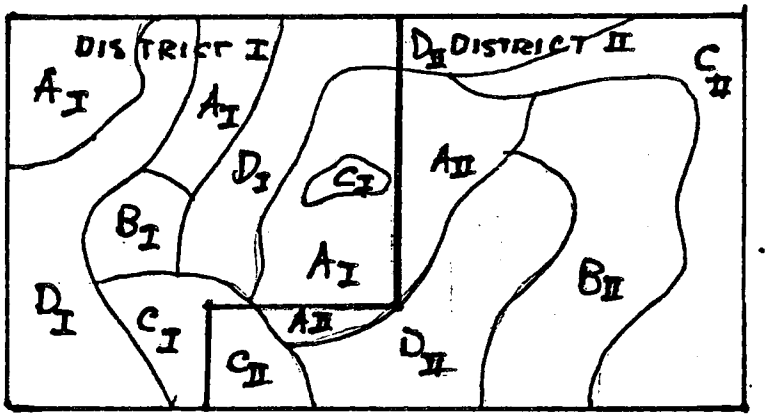

Figure 1b: Land classification with district level location information

Land strata = stand type * district

Number of strata = 8

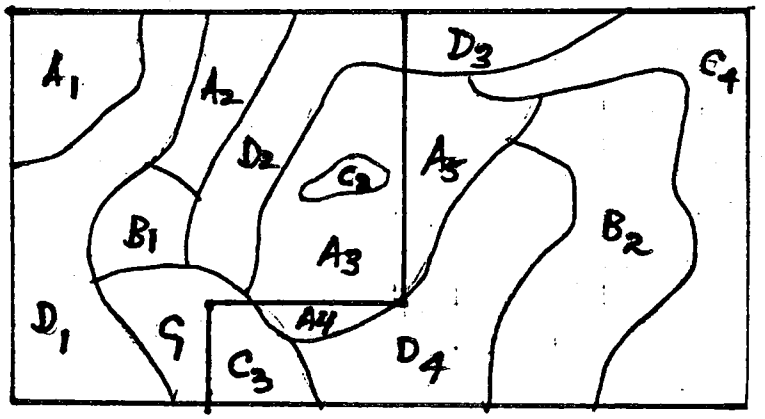

Figure 1c: Land classification with complete location information to the contiguous stand level.

Land strata = stand type * district * contiguous stand
Number of strata = 15

Stand type	District I	District II
A	A1,A2,A3	A4,A5
B	B1	B2
C	C1,C2	C3,C4
D	D1,D2	D3,D4

Figure 1. Land classification for management analysis with different degrees of location information.

of visual, graphic, and partial analytical information. A working definition; "A plan is spatially infeasible when the temporal and locational assignment of plan activities to specific land areas is judged unacceptable because of the location and time of treatment of these acres relative to the time and location of activities assigned to adjacent or nearby acres. A corollary to this judgmental definition is: the appropriate people have been identified and empowered to make the judgments.

The judgments of infeasibility can be for many reasons: technical, biologic, economic, aesthetic or legal. For example, technical infeasibility would be when no equipment is available for logging steep, erosive sites. It would be economically infeasible when the technology is available but the evaluation shows a negative present net worth due to location and access costs. Areas treated may disrupt wildlife migration routes or break up the minimum contiguous acres needed for shelter or reproduction (e.g. elk calving areas free from human disturbance and having the right vegetative edge conditions). Aesthetics and visual quality relate to how things blend or harmonize visually from the vantage point of a human observer at a specific location on the ground -- this too can easily render a judgment of spatial infeasibility.

Until we have much more experience at considering and articulating the spatial feasibility problem, attempts to move to an objective analytical definition will and probably should remain tentative and the immediate task is to refine the conceptual basis for judgements.

One of the most important contributions of a comprehensive geographic information system such as ECOSYM would be to provide information helpful in determining before plant implementation whether or not a particular activity schedule would be spatially feasible. Such evaluation could take place on the input side before or during planning model analysis to ensure that only spatially feasible alternatives

are being considered. If not done before, then on the output side an untested schedule produced by the planning process can be evaluated to see if a spatiall feasible time and location schedule can be found.

Spatial evaluation before and during planning is much more effective when land stratification with some location identity such as depicted in Figure 1b and 1c is used. If no locational identity in the stratification is used (Figure 1a) then the only choice is to locate and evaluate schedule assignments after the planning analysis.

OBJECTIVES

After the original objectives of detailed operational testing was dropped the main thrust of the effort was re-directed to investigate how ECOSYM could support forest planning using FORPLAN with particular emphasis on the concept and issues of spatial feasibility. Specifically

(1) To continue using and developing ECOSYM to ensure that the conceptual basis is sound and that the computer system can effectively transfer the concept into application.

(2) To define the spatial feasibility within the context of forest planning.

(3) To identify specific spatial information and analysis needs for FORPLAN based forest planning.

(4) To demonstrate by example how ECOSYM can support the spatial analysis required for several representative and important planning problems.

(5) To demonstrate the operational applicability of the analytical approaches using existing Payette and Willamette national forest data bases.

(6) To present the ideas and results of this ECOSYM and study to appropriate clientele groups to evaluate transfer and sustain the technology.

MAJOR STUDY ACCOMPLISHMENTS

A variety of activities, presentations, papers, and proposals and improved technology have resulted from this study. They are first itemized and secondly discussed in the framework of the study objectives.

Itemized Results

Papers

(1) Ryberg, Steven F., 1983. Spatial Feasibility in Forest Planning. M.F. paper. Utah State University, Logan 55p.

(2) Davis, Lawrence S., Lynn Delain and Peter Parks, 1982. Quantification and Use of Spatial Relationships in Forest Management and Planning: Some Concepts, Procedures and Costs. Paper presented at general technical session, western forest economists meeting, Wemme, Oregon. mimeo

(3) Davis, Lawrence S. and Lynn Delain, 1984. Integrating wildlife models into FORPLAN using ECOSYM. Paper to be presented and published in proceeding of the Symposium Wildlife 2000: Modeling Habitat Relationships of Terrestrial Vertebrates, October 7-11, 19844 at Lake Tahoe.

Reports and Manuals

(4) Delain, Lynn. Costs, procedures, and results of an analysis to create the analysis areas used by the Willamette and Payette national forests using actual forest data bases and the SPANMAP system.

(5) Demonstration problem set, used as an initial tutorial user's guide for SPANMAP.

(6) Davis Lawrence S and K.N. Johnson, 1983, Land Classification and Growth

Concepts for Yield Projections and Forest Planning. Draft Chapter 2 for the third edition of Forest Management McGraw Hill book company to b released Fall 1984. This chapter draws heavily on the ECOSYM concept to set the stage for contemporary forest planning.

Proposals

(7) A research proposal was submitted to Land Management Planning (USFS Ft. Collins) at their invitation following preliminary discussion and a presentation of ECOSYM/SPANMAP. The proposal is for a cooperative program of research to work out practical procedures for spatial analysis in forest planning by linking ECOSYM/SPANMAP to the new FORPLAN II. This proposal received the support and approval of the Ft. Collins Land Management Planning Group and is now in process at higher agency levels.

Technological Development

(8) SPANMAP, the computer system for ECOSYM has been converted to Fortran 77 and installed on the IBM 4341 at the University of California, Berkeley. Many of the analytical programs have been substantially improved, particularly the DRAW, DUMP, TABLE, RECODE, and EQUATION routines in the RULES program. As of this report we are currently developing techniques for user input of location specific activity schedules for subsequent evaluation. A revised user manual for SPANMAP will be issued when this last addition is tested.

(9) In connection with the proposal (item 7), SPANMAP and the MANTI, Tanner Creek, Willamette, and Payette data bases have been installed at the FCCC. Thus, the system is now in a position for test operational use by the national forests. We also will explore the potential for modifying the

system for use on the forthcoming new GIS system of the USFS and/or to modify the existing RIDS or R2-MAP systems to include some of the more desirable features of SPANMAP.

(10) ECOSYM/SPANMAP has been used in three separate graduate courses to support 3-6 week segments of instruction on land classification and information systems. The first two courses were at Utah State University and reached about a dozen students including Jim Riley, Mark Rasmussen, Bill Anthony, Debbie Kuehne, Ken King, Bill Lavere, Steve Ryberg, Scott Roberts, Rob Evans, and Dave Iverson. The third course is in the fall of 1983 at the University of California and has 6 students. In all three sessions the ECOSYM conceptual framework was found acceptable and the SPANMAP Computer System was used successfully for a series of student problems; lending some support to our belief that this is an operational system.

DISCUSSION OF OBJECTIVE ACHIEVEMENT

Objective 1: Continued Use, Development, and Evaluation of ECOSYM

Over the three year period of this study the ECOSYM concept has been developed and evaluated. While the failure to have a controlled full scale operational demonstration on the Manti was disappointing, the demonstrations with the Tanner Creek, Willamette and Payette data bases provided an opportunity to explore how ECOSYM/SPANMAP could support various aspects of forest planning using FORPLAN. The demonstration in the WFE paper (accomplishment 2), the Willamette Payette analysis (accomplishment 4) and the use in classes (accomplishment 10) confirmed its value in application and at the same time suggested many of the developmental changes (accomplishment 8). Finally the system was favorably evaluated by the Willamette planning staff at a presentation in Eugene (March 1983), at a workshop with technical FORPLAN

staff at the WFE meeting (May 1983) and in a presentation to the Land Management Planning Group, Fort Collins in June 1983. The next step will be to use the syste to support FORPLAN with the 20,000 acre Tanner Creek data base and to locate a suitable national forest for operational testing. An ECOSYM data base is currently being constructed for intensive high resolution analysis of the 3,000 acre Blodgett Forest Research Station of the Department of Forestry, University of California, Berkeley.

Objective 2: To Define Spatial Feasibility

The earlier discussion in this final report and the M.F. thesis of Steve Ryberg (accomplishment #1) provide the status on this effort. While we are comfortable with the conceptual framework, the quantitative and economic significance of evaluations as to spatial feasibility or infeasibility need working out on scaled data bases. When this is developed further a journal paper on the conceptual basis of spatial feasibility will be prepared.

Objective 3: Identify Specific Spatial Information Needs to Support FORPLAN

Many of these are developed in Ryberg's thesis (accomplishment #1) and others are presented in the WFE paper (accomplishment #2). The most important and obvious needs are straightforward: (1) to locate analysis areas, and capability units on the ground, (2) to evaluate the impact of various plan implementation schedules in terms of location specific impacts such as erosion, available timber, or costs and (3) to have a convenient and cheap way to count and locate areas by various cross stratifications.

Evaluating alternate analysis area strategies -- the basic classification of land for planning purposes -- seems to be a very important need. Currently, the decision about how to classify is made early in the planning process and al-

subsequent analysis, data collection and model building uses this as the framework. Because of time and money costs, there is little incentive to try other classification strategies once the planning process is underway.

The ability to pre evaluate alternative location specific packages of prescription within aggregate emphasis or allocation scheduling zones to ensure that only feasible, implementable options are considered in forest wide FORPLAN analysis is a critical need. If such analysis is not done on the input side, then FORPLAN solution activity schedule need to be located and evaluated in place to see if they are in fact feasible. Identifying activity and output schedules for planning construct of coordinated allocation scheduling zones seems to provide exactly the type of analytical problem ECOSYM is designed to effectively help solve.

Objective 4: To demonstrate how ECOSYM can Support Forest Planning

The elk habitat input analysis in the WFE paper along with the problems demonstrated in the user's tutorial (accomplishment 5) provides this. We are confident at this point that a wide range of useful planning information can be provided by ECOSYM/SPANMAP and that the analytical capabilities of SPANMAP are flexible and adaptive to a wide range of applications.

Objective 5: Analysis Areas of the Willamette and Payette National Forests

The Willamette and Payette analysis were undertaken to show that (1) existing grid data of a forest could be easily established in SPANMAP and (2) that the system can efficiently reproduce the analysis area derivation procedures used by the forest. In both cases the forests did much and the actual work by hand because of limitations and difficulty with available computer systems.

We were pleased to be successful in our demonstration but feel that the process

could now be conceptually simplified and done much quicker if redone in cooperation with each forest.

It took about 7-8 person days for each forest, most of which was spent locating and correcting errors in the data bases provided by the forest. We are certain that if the data base was correct initially, only one day of analysis would have been needed for each forest.

Our experience with these forests confirmed again the basic ECOSYM assertion that if accurate, objective, location specific information about the physical, biological, and developed characteristics of land resources is established initially, then a broad range of efficient analysis can be supported. The Payette data is close to this concept but they do not have a functional computer system to work it.

Objective 6. To Present the Concepts and Results of this Study to Appropriate Clientele Groups

A review of the accomplishments list indicates that this has and will continue to be done. The Paper at the wildlife 2000 paper, the cooperative work with land management planning and continued research will sustain ECOSYM.

Persons interested in report copies or further information about ECOSYM and SPANMAP should contact Dr. Lawrence S. Davis, Department of Forestry and Resource Management, 145 Mulford Hall, University of California, Berkeley 94720. (415) 642-6489.

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